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**BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES**

MAILED

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Technology Center 2600

Application Number: 09/584,796
Filing Date: June 01, 2000
Appellant(s): LINDQVIST ET AL.

John Lastova (33149)
For Appellant

EXAMINER'S ANSWER

1-2-2008

This is in response to the appeal brief filed ~~[illegible]~~ appealing from the Office action mailed 8-9-2005.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

US Patent to Ho et al. (5317596)

US patent to Dowling (6597745)

US Patent to Chaffee et al. (5117418)

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. **Claims 1,3-7,9-17,20-28,30-43,** rejected under 35 U.S.C. 103(a) as being unpatentable over Ho et al. (5317596), and further in view of Dowling (6597745).

As per **claim 1,** Ho discloses an echo canceller used in a transceiver (ABSTRACT). The device comprises electronic circuitry configured to estimate and remove echo signals in the frequency domain (Fig. 3 Col 5 line 65 to Col 6 line 22). However, Ho does not disclose that the echo signals are estimated with a combination of both a product of a first matrix and transmitted symbol and a product of a second matrix and a previously transmitted symbol.

Dowling teaches an adaptive precoder that enables a block oriented receiver to recover a datastream in the presence of ISI and noise (ABSTRACT) that will reduce computational complexity over previous implementations (Col 2 lines 40-55). He further suggests that the precoder may be implemented in (merged with) an echo canceller (Col 22 lines 1-17). The precoder detects and compensates for noise (and ISI) in the signal using a combination of both a product of a first matrix and transmitted symbol and a product of a second matrix and a previously transmitted symbol (Fig. 5 Col 17 lines23-65). It would have been obvious to one of ordinary skill in the art at the time of this application to implement the precoder's functionality with Ho's echo canceller to produce an echo signal (in the frequency domain) for the advantage that the precoder (and as such, the echo canceller) takes into account ISI and ICI (noise) and provides reduced computational complexity.

As per **claims 12,24,37,38,** claims rejected for same reasons as claim 1. Additionally, Dowling discloses that the input signal vector may be multiplied with a column vector (Col 9 lines 15-55).

As per **claims 20,30,35,** claims rejected for same reasons as rejection of claim 1. Additionally, Dowling discloses that the precoder takes into account the effects of ICI (Col 8 lines 60-67).

As per **claims 3,13,26,32,43,** Dowling discloses that the input vector (and as such, the delayed vector) is hermitian-symmetric and is divided into real and imaginary parts (the imaginary parts are ignored) before matrix processing (Col 9 line 15 to Col 10 line 5).

As per **claims 4,5,22,31,** the first matrix (DOWLING: Figs 3,5) has coefficients that represent how an echo from a currently transmitted signal affects a received signal, and the second Matrix (DOWLING: Figs 4,5) represents how an echo from a previously transmitted signal affects the received signal.

As per **claims 6,7,34,36,** Ho discloses that the circuitry adapts the echo canceller coefficients (coefficients of the matrices) using a difference between the receive signal and the echo estimate signal using an lms algorithm (device 58, Fig. 3, Col 6 lines 50-62).

As per **claim 9,** Dowling discloses that the device may be implemented in a DMT transceiver (ABSTRACT).

As per **claim 10,** Dowling discloses that the Matrices may be NxN matrices (Col 7 lines 30-50).

As per **claims 11,33,42,** Dowling discloses that the device will function for a vector communication signal (which inherently includes, by definition, the transmit,

receive, and echo estimate signals) such as a DMT system with Hermitian symmetric signal points (Col 2 lines 58-67).

As per **claims 14,15,23,** Dowling discloses a compensation (twiddle) factor (applied to both matrices) to compensate the previously transmitted signal that is a complex exponential term (Col 11 line 53 to Col 12 line 25, Col 14 lines 5-15). The twiddle factor is also applied to the triangular submatrix formed to compensate for a cyclic prefix (Col 20 lines 49-60). Dowling also discloses the device is used in a DMT type transceiver (ABSTRACT).

As per **claims 16, 17,27,28,40,41,** Ho discloses that for applications involving asymmetric data, the signal should be decimated or interpolated as appropriate (Col 7 lines 49-62).

As per **claim 21,** claim rejected for same reasons as rejections of claims 1 and 9.

As per **claim 25,39,** the matrix is combined with a difference between the current transmit signal and the product of the delayed signal (previously transmitted) and the compensating factor in the matrix (as per rejection of claim 14) (DOWLING: Fig. 5).

3. **Claims 18,19** rejected under 35 U.S.C. 103(a) as being unpatentable over Chaffee et al. (5117418), and further in view of Dowling (6597745).

As per **claim 18,** Chaffee discloses an echo canceller used in a transceiver (ABSTRACT). The device comprises electronic circuitry configured to estimate echo signals in the frequency domain, convert the estimate to the time-domain, then subtract

the estimate in the time domain (Col 3 line 5 to Col 4 line 10). However, Chaffee does not disclose that the echo signals are estimated with a combination of both a product of a first matrix and transmitted symbol and a product of a second matrix and a previously transmitted symbol.

Dowling teaches an adaptive precoder that enables a block oriented receiver to recover a datastream in the presence of ISI and noise (ABSTRACT) that will reduce computational complexity over previous implementations (Col 2 lines 40-55). He further suggests that the precoder may be implemented in (merged with) an echo canceller (Col 22 lines 1-17). The precoder detects and compensates for noise (and ISI) in the signal using a combination of both a product of a first matrix and transmitted symbol and a product of a second matrix and a previously transmitted symbol (Fig. 5 Col 17 lines23-65). It would have been obvious to one of ordinary skill in the art at the time of this application to implement the precoder's functionality with Chaffee's echo canceller to produce an echo signal (in the frequency domain) for the advantage that the precoder (and as such, the echo canceller) takes into account ISI and ICI (noise) and provides reduced computational complexity.

As per **claim 19,** claim rejected for same reasons as rejection of claim 18. Additionally, Dowling discloses that the input signal vector may be multiplied with a vector (Col 9 lines 31-55).

4. **Claim 44** rejected under 35 U.S.C. 103(a) as being unpatentable over Chaffee et al. (5117418) as applied to claim 35, and further in view of Dowling (6597745).

As per **claim 44,** Chaffee discloses an echo canceller used in a transceiver (method of reducing an echo) (ABSTRACT). The device comprises electronic circuitry configured to estimate echo signals in the frequency domain, convert the estimate to the time-domain, then subtract the estimate in the time domain (Col 3 line 5 to Col 4 line 10). However, Chaffee does not disclose that the echo signals are estimated with a combination of both a product of a first matrix and transmitted symbol and a product of a second matrix and a previously transmitted symbol.

Dowling teaches an adaptive precoder that enables a block oriented receiver to recover a datastream in the presence of ISI and noise (ABSTRACT) that will reduce computational complexity over previous implementations (Col 2 lines 40-55). He further suggests that the precoder may be implemented in (merged with) an echo canceller (Col 22 lines 1-17). The precoder detects and compensates for noise (and ISI) in the signal using a combination of both a product of a first matrix and transmitted symbol and a product of a second matrix and a previously transmitted symbol (Fig. 5 Col 17 lines23-65). It would have been obvious to one of ordinary skill in the art at the time of this application to implement the precoder's functionality with Chaffee's echo canceller to produce an echo signal (in the frequency domain) for the advantage that the precoder (and as such, the echo canceller) takes into account ISI and ICI (noise) and provides reduced computational complexity.

(10) Response to Argument

Responses to Appellant's Argument A.

As per appellant's argument that the Ho reference (used in rejecting claims 1,12) does not teach removing echo in the frequency domain, examiner notes Fig. 3 of Ho where echo canceller 100 cancels a frequency domain echo estimate E(f) from a received signal (path 104) via frequency domain subtractor 58. Appellant makes the comment that Ho cannot remove echo due to a previous symbol in the frequency domain (appellant's arguments page 17 last paragraph). Examiner does not understand this statement because all echo is a delayed copy of a previously transmitted signal (symbol) and Ho functions to remove any echoes (caused by previous symbols). Examiner notes encoder 12 disclosed in Ho Fig. 3 which would comprise the functionality taught by Dowling's precoder (which includes the "combination of a product of a first matrix with a currently transmitted signal and a second matrix product with a previously transmitted signal"). Those computations would be taken into account by signal X(f) (Ho Fig. 3) and x(n) which are used by the echo canceller 100 in estimating (and subtracting) the echo signal.

As per appellant's argument that Dowling discloses a pre-equalizer (pre-coder) that does not cancel echoes (appellant's arguments page 9), examiner agrees. However examiner notes that the claim rejections were made on either Ho or Chafee in view of the teachings of Dowling. Ho and Chafee disclose the echo cancellers. Dowling discloses a method of signal pre-coding that will reduce the effects of ISI and ICI. Dowling teaches

a precoding stage that would be implemented in Ho as the 'encoder' block 12 (Ho, Fig. 3). Dowling even contemplates combining the functionality of the precoder with an echo canceller (Col 22 lines 1-5) as they are directed towards the same function: ie. reducing noise from signaling. Appellant argues that the distortion compensation taught by Dowling is completely different that the canceling of an echo disclosed by Ho and Chafee, examiner notes that they are two functions performed on a transmitted signal in order to reduce the noise in the signaling. Dowling pre-codes a signal but also contemplates that the precoding function be merged with an echo canceller.

Response to appellants argument 1 (under argument A)

The examiner notes that appellant is repeating the same arguments as presented on page 18 of the appeal brief. The examiner repeats the above responses pertaining to the relation of the precoding function (Dowling) to the echo cancellation function (Ho Chaffee).

As per appellant's arguments that compensating for channel distortion (as per Dowling) does not compensate for echo (as per Ho), examiner notes that Dowling teaches implementing an algorithm that makes a transmitted signal more resistant to ISI and ICI. The algorithm involves steps (product of various matrices for example) that read on the steps claimed by appellant. Dowling contemplates the combination of the precoding algorithm with an echo canceller because both act on the outgoing transmitted signal. Any echo canceller will have to be aware of the precoded signal in order to form an accurate echo estimate and function correctly (that is why Ho uses the encoded transmit signal to form the

echo estimate in Fig. 3). Appellant poses the question "why would Dowling model/estimate echo at a near end station". Examiner notes that Ho/Chafee are relied upon to teach estimating an echo at the near end. When combined with Dowling's precoder, the echo cancellers would estimate echo signals based off the precoded tranmit signals and the estimate echo signals would take into account the improved resistance to ISI and ICI (an echo of a coded signal would maintain all the properties of the coded signal, it would be a delayed version at a lower amplitude). If the transmitted signals were resistant to ISI and ICI, then the respective echo estimates would also be resistant to ISI and ICI. This is the **same** function as claimed by appellant (note: appellant's spec page 4 lines 17-18). The precoding uses a model of the transmission channel (which includes the echo path) that takes ISI/ICI into account (Dowling), and the echo canceller estimates echo using a frequency domain model based off the precoded signal (Ho/Chaffee).

Regarding appellants statements regarding the near end and far end, the examiner repeats a section of response to appellant's arguments from the final office action dated 8-9-2005:. Examiner notes that the use of near end and far end systems by appellant is arbitrary as the precoder and echo canceller could obviously be implemented at **both** ends of a communication system with the outgoing transmit signal being precoded and the incoming received signal being echo cancelled. For the sake of argument, examiner will explain the combination of Ho and Dowling in a 'near-end' situation. When Dowling's precoder is implemented (at the near-end) the signals that are transmitted out on the line will be the pre-coded signals. As such, in order for a near-end echo canceller to function correctly, it must analyze the outgoing signal and create an echo estimate from that signal. Since the signal is a

precoded signal, the precoded signal must be fed into the echo canceller so that the echo canceller can correctly estimate the echo that is going to be reflected back and potentially interfere with the received signal (this is shown in Ho Fig. 3 as the signal ENCODER 12 is implemented before the transmitted signal is fed into echo canceller 100). As such the echo estimate is created by 'using' (as per appellant's claim 1 language) a precoded signal, which is a combination of matrix coefficients of currently and previously transmitted signals. The Dowling reference clearly anticipates this combination when he states that an echo canceller may be **'merged'** with the precoder (as referenced in the previous office action). The Examiner, after providing the above explanation to the appellant, had requested appellant to offer an explanation as to how the precoder and echo canceller would be merged (as specifically disclosed by Dowling) and not function as per appellant's claim language, but appellant has yet to offer any alternative explanation. Examiner notes that the precoding is used to mitigate interference between waveforms (carriers and symbols) within the outgoing signal, while the echo canceller is only concerned with estimating the echo of any signal that is being transmitted on the transmission line. They are being used for two different functions that may simultaneously be combined and implemented as contemplated in the Dowling reference. However, the echo canceller must take into account the precoded signal in order to effectively cancel the outgoing waveform echo (which is based off of the precoded output signal).

As per appellant's comment that examiner has made a premise that Dowling's Precoder removes echo (appeal brief page 20 first paragraph), The examiner does not make that

premise, and contends that the appellant is not considering the references in combination as described above.

Response to appellants argument 2 (under argument A)

As per appellant's arguments that Dowling's precoding is based on the transmission channel while the echo canceling is based off the echo channel transfer function, and as such the prior art combinations fall short, the examiner disagrees. The purpose of echo cancellers is to iteratively detect the echo path in order to produce an echo estimate. The echo path is detected using transmitted signals. An echo path estimate based off an ISI/ICI resistant precoded signal will be based off the transmission channel used in precoding the transmit signal. Examiner additionally notes appellant's own specification that contradicts appellant's arguments. Appellant's specification Background section page 3 lines 18-21 states that a received echo signal will also be affected by the ISI and ICI because all practical channels have memory. Examiner notes that "**the ISI and ICI**" refers to the ISI and ICI mentioned in the previous paragraph where appellant notes that ISI and ICI are based on the transmission channel. The idea that the precoded outgoing signals are the outgoing signals used by the echo canceller is

already contemplated by Dowling when he discloses that the precoder and echo canceller may be **merged.**

The appellant is attempting to separate the 'echo path' (Ho/Chaffee) from the 'transmission channel' (Dowling), but the echo path is directly based on the transmission channel. The transmission channel is what provides the impedance mismatch (which causes the echo to begin with) that appellant is referring to ! The transmission channel transfer function also is the reason for the long impulse response of echo path channel.

Response to appellant's argument 3 (under argument A)

As per appellant's argument that Dowling's teachings would only serve to further distort the echo estimate, examiner does not understand appellant's point. Dowling does not merely pre-equalize a signal according to an inverse channel estimate, Dowling provides an iterative encoding algorithm to increase the signal's resistance to ISI and ICI. Whatever function is performed on the transmit signal will be taken into account by the echo canceller because the encoded (or precoded) signal will be used when making the echo estimate (Note the Encoder 12 in Ho Fig. 3 that acts on the signal before it is sent to the echo canceller). Furthermore, examiner notes that echoes may arise from an impedance mismatch at any point of the transmission channel, so any precoding of a transmitted signal that reduces possible ISI or ICI will also reduce the ISI and ICI in the reflected echoes.

As per appellant's argument that combining the precoder/echo canceller destroys Dowling's purpose of a reduced complexity precoder structure, examiner notes that the 'precoder-structure' would not be increased in complexity, only merged with the functionality of an echo canceller. If anything the process would be less complex because operations common to the precoding/echo cancellation can be combined.

As per appellant's argument that Ho in view of Dowling would compensate for transmission channel ISI, not the echo ISI (appellant's arguments page 13 middle paragraph). The echo ISI is based off the transmission channel ISI as per appellant's specification page 3 lines 8-22 (as noted above). Examiner contends that the motivations to combine references as previously noted are adequate.

Response to appellant's argument 4 (under argument A)

As per appellant's arguments that Ho and Dowling do not compensate for Echo ICI and ISI. Examiner again notes appellant's specification page 3 that states that the echo ICI and ISI is based off the transmission channel ISI and ICI. An echo canceller using a precoded signal as a reference signal will estimate echoes of said precoded signal. If the reference signal takes into account ICI and ISI then the echo estimates will take into account ISI and ICI because the echo is based off the precoded, transmitted signals being applied to the transmission line.

Examiner further notes that ICI is dependant upon ISI (ISI can cause ICI) and reducing ISI in a signal will also function to reduce ICI in that signal. Appellant's specification notes that ICI may be caused by transients in the symbol transitions (specification page 3 lines 8-17). ISI may cause additional transistions which create additional ICI. Furthermore, examiner contends that the intra-block distortions mentioned by Dowling refer to ISI and the inter-block refers to ICI (DOWLING: Col 8 lines 60-67).

Responses to Appellant's Argument B, and arguments 1,2 and 3 under Argument B

As per appellant's argument that Chaffee does not disclose an echo canceller that cancels echoes in the frequency domain (as per independent claims 1,12,18,19) (appellant's arguments page 8). Examiner notes that claims 1,12 do not refer to canceling the echo in the frequency domain, only estimating it. Examiner further notes that Chaffee is not used as a reference in rejecting independent claims 1,12. Examiner further notes that independent claims 18,19 recite estimating the echo signal in the frequency domain and then canceling the echo estimate from the received signal in the time domain. Chafee does teach those elements: (CHAFFEE: Col 3 lines 10-25) teaches estimating echo in the frequency domain and (CHAFFEE: Col 4 lines 1-10) teaches canceling (subtracting) echo in the time domain.

The examiner notes that the appellant has repeated the same arguments for B-1,B-2,and B-3 as those used in the Arguments A-1,A-2,A-3. The examiner contends that the above responses to the arguments still apply. Any echo canceller (that of Ho or Chaffee) must use the outgoing (precoded) signal in order to function correctly (as shown in Ho)

Additional Comment for the Board's Consideration

The function taught by Dowling is a specific form of encoding a signal before it is transmitted (precoding). The encoding takes into account the ISI and ICI of the channel. When the Dowling encoder is implemented in the Ho system, it must be implemented at the 'encoder 12' block (Ho Fig. 3) in order for the echo canceller disclosed by Ho to function correctly. Note that the **encoded** signal is sent to the echo estimation stage 100 of Ho (Fig. 3). This is because an echo canceller must know what the outgoing signal is in order to be able to estimate the echo. The function of the echo estimation stage 100 is to estimate the 'echo channel'. When Dowling's precoder is implemented in the encoder stage of Ho, then the outgoing signal will take into account the ICI and ISI of the transmission channel. When the encoded signal is sent to echo estimator 100, estimator 100 will estimate the echo channel and use the encoded signal and echo channel estimate to produce an echo estimate (see Ho Col 1 lines 15-45). The echo estimate will be based off signals that take into account the transmission channel. If the signals transmitted (and also fed into the echo path estimator 100 of Ho) take into account the transmission channel ICI and ISI, then the echo estimate will also take into account the effects of the transmission channel that cause ISI and ICI in the echo channel. The echo channel is

derived, in part, from the transmission channel. The whole purpose of the echo canceller stage 100 in Ho Fig. 3 is to estimate what happens to the outgoing signals when they are sent on the transmission channel, that estimate is an estimate of the echo channel. The echo channel is based on both the outgoing signal properties and the transmission channel properties. If the outgoing signals are resistant to transmission channel ISI and ICI, then the echo estimate is resistant to the echo channel ICI and ISI in order for the canceller to function correctly. Dowling already contemplates this when he states that the precoder may be merged with an echo canceller. Furthermore, examiner notes that none of appellant's claims refer to ISI or ICI caused specifically by the echo channel, only that the echo channel estimate takes into account the effects of ICI or ISI (appellant's claims 20-21). The echo estimator 100 of Ho Fig. 3 will take into account the effects of ISI or ICI because it relies on precoded signals (which take into account ISI or ICI) from the Dowling precoder implemented in the encoder stage 12 of Ho.

Furthermore, examiner notes an additional viewpoint for consideration by the board concerning appellant's above argument. It being that the echo canceller of Ho would function to remove all forms of echo. When the echo canceller has 'converged' (Ho Col 6 line 34-49), then the echo canceller will produce the exact echo estimate which is based off the transmitted signals and the echo path. The echo estimate will completely cancel the echo from the received signal. This echo would include echo caused by ISI, ICI or any other echo channel properties (such as an impedance mismatch in the transmission channel). As an example, if carrier A produces 'echo ICI' in carrier B (the 'effects of ICI' of appellant's claim 20), then a converged echo canceller would still see the 'echo ICI' in carrier B as echo, and adaptively estimate and cancel

that echo because the echo canceller is using the originally transmitted carrier B as a reference (before it is corrupted by echo from any sources).

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

Alexander Jamal

Conferees (pre-appeal conference made on 6-15-2006):

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